RURAL ECONOMY IN YUCATAN AND THE IMPACT OF COVID-19

Javier Becerril García*
Francisco Iván Hernández Cuevas**
Rafael Ortiz Pech***

ABSTRACT: In the second trimester of 2020, Mexico's GDP fell by 53.2% due to the mitigation actions against SARS-CoV-2 virus. We prepared a Social Accounting Matrix for the Geohydrological Reserve "Anillo de los Centoes" in Yucatan and employed two Leontief type multi sectoral analysis. The first models a 3-month loss in household income. The result was a -24.19% drop in GDP, with an impact on all productive and service activities. The second scenario models a 5-month loss of income. The GDP fell to a critical: -40.13%.

Keywords: COVID-19, multisectoral analysis, Social Accounting Matrix, rural income

1. INTRODUCTION

Measures in Mexico and around the world to mitigate the spread of SARS-CoV-2 resulted in a drastic economic slowdown during the first and second trimesters of 2020. The current and future impact on the population's income is expected to be particularly acute in Mexico (IMF, 2020). The country could experience the sharpest recession among the G-20 economies (Moody's Investors Services, 2020) and one of the deepest declines in Latin America (ECLAC, 2020). Throughout the last semester, growth expectations of the Gross Domestic Product (GDP) for 2020 have decreased and are in a contraction

* PhD in agriculture economy from Kiel University, Germany. He is a research-professor at the Economy School at Universidad Autónoma de Yucatán (UADY).
** PhD in social science from Universidad Autónoma de Yucatán (UADY). Has been part of Conacyt's post-doctoral program 2020-2021, Facultad de Economía de la Universidad Autónoma de Yucatán.
*** PhD in economy from Universidad Autónoma de Baja California (UABC). He is a research-professor ate the faculty of economy at the Universidad Autónoma de Yucatán (UADY).

between 7 and 9% per year. In April, 555,000 job losses were registered in the country (IMSS, 2020). The Federal Government forecasts a total of 1 million job losses due to the epidemic. Others estimate that this could be the figure only for Cancun (*Diario de Yucatán*, 2020) and that COVID-19 could still plunge between 12 and 16 million Mexicans into poverty (Li Ng, 2020).

As governments around the world declare unprecedented countercyclical measures –these economic and fiscal stimuli interventions represent up to 10% of GDP in other countries– to face the pandemic's repercussions, different stakeholders have casted doubts regarding the reactivation economic plan proposed by the Mexican government (FitchRatings, 2020). International rating agencies mention that Mexico's "modest fiscal stimulus" of just 0.7% of the GDP, could represent one of the weakest recovery among Latin American economies by 2021" (Standard & Poor's, 2020). Other factors such as the deterioration of the fiscal situation, the limited response of the government and the uncertainty generated by its policies could ultimately raise the country risk significantly, compromising the rating of Mexico´s debt (Moody's Investors Service, 2020).

The current context considers the reduced performance of the Mexican economy before the pandemic along with the federal administration's "new expenditure model" established in the 2020 Federal Expenditure Budget and the programs it prioritizes, as well as the recent statements by Mexico's President regarding "the new economic policy in times of coronavirus". The opposition in congress rejects the reform to the Budget and Fiscal Responsibility Act, which seeks greater discretion in the spending powers by the executive branch, as well as the legal obstacles that the Accord regarding the Reliability, Security, Continuity and Quality Policy of the National Electric System faces (Quadri, 2020).

Likewise, the Federal government has the authority to acquire public debt and finance the nation's economy reactivation, ensuring businesses' needs and advance a speedy recovery. The President of Mexico emphasizes the importance of alternative welfare measures in contrast to sole market activity growth. These measures should reflect the vital contribution of the environment to human welfare and favor a sustainable and resilient economy.

Economic theory defines business cycles by three basic stages: recession, recovery, and expansion. Currently Mexico's economy has not yet reached its lowest point. For example, it is not yet known with certainty the extent of the GDP's fall of the country's economy. Banco de México (Mexico's central bank) in its trimester report January-March forecasted a GDP decline of approximately 8.8% (Banco de México, 2020). Recovery could start probably in the second semester of 2020, when the economy begins to grow –and the

recession ends–. The economic recovery will end when GDP growth achieves its previous maximum point, prior to the slowdown of the Mexican economy –beginning of the first trimester of 2020–. From that moment the expansion of the economy will begin, most likely in 2022.

The economy in Yucatan is in a dire recession situation (due to the contraction of local, national and international demand). Therefore, extraordinary measures such as a strategic change in its economic policy must take place, resorting to the state's fiscal deficit. In other national or international economies, programs are already underway to counteract job losses and support those who were left without an income due to the pandemic.

On March 24, 2020, the Federal Government published the preventive measures to implement, mitigate and control the health risks by SARS-CoV-2 virus (COVID-19) (DOF: 03/24/2020). These measures known as "Jornada Nacional de Sana Distancia" with a duration from March 24 to May 30, 2020, aimed to achieve "social distancing" and mitigate the transmission of SARS-CoV-2, reduce the number of person-to-person infections and thus its dissemination. It established the need to avoid attending work centers, going outdoors, visiting public places, suspension of school activities, as well as non-essential economic activities. On May 14, 2020, a "New Normal" decree was published to start on June 1. The decree established a strategy to reopen social, education and economic activities. It included a traffic light system by regions to evaluate weekly the epidemiological risk as activities in each state reopened, and establish specific actions if necessary (DOF: 05/14/2020). This "new normality"[1] consists of an economic reopening in a responsible and safe manner, monitoring weekly the contagion risk by region; the traffic light color indicates which economic, education and social activities are possible. By November, Stage 3 was in force, which began on June 1. Yucatan transitioned from red to orange of a total of four colors, green allowing activities "without restrictions". At the national level, of 32 states only two, Chiapas and Campeche were positioned in green, several states, returned to red, and had to close strategic economic sectors.

Within this scenario, it is essential that the Federal Government as well as state governments procure rigorous and systematic quantitative knowledge regarding the direct and indirect effects of the social and economic recession and contest the spread of COVID-19. Therefore, we place the following question: What are the social and economic implications of shutting down the economic activity of strategic "non-essential" sectors in Yucatan for three and five months?

1 www.gob.mx/covid19

Without doubt, COVID-19 has stuck household economy of thousands of families in Yucatan. The state government´s efforts have been substantial, but the dimension and depth of this crisis is immeasurable due to the global economic slowdown. The closure of key sectors of the national economy such as: tourism, restaurants, construction and non-essential services (considered growth generators with multiplier effects due to their links in the production chain, and the creation of direct and indirect employment), has forced small, medium and large businesses to strive to sustain their operations and at the same time close for a period of three to five months, and keep their workforce in lockdown. Currently using their savings, taking loans, or partial payroll payments and technical closures, all have been unsustainable. Many businesses have bankrupted and consequently employment sources have been lost. Family testimonies regarding economy detriment are overwhelming, even more so if the death of a member of the family is involved.

Our hypothesis is for this study is that the full closure of "non-essential" economic activities is the best strategy –cost effective– to halt the transmission of COVID-19 which has caused a loss of household income slightly higher than 30%.

We seek to quantify the direct and indirect effects of the partial or total closure of the economic activity in Yucatan and the consequential loss of family income during the three and five-month lockdown that the "Jornada Nacional de Sana Distancia" and the "New Normality" stipulated for non-essential economic activities.

To answer our research question, and substantiate our hypothesis, this analysis studies the region of Anillo de los Cenotes Geohydrological State Reserve (REGHAC-recarga, in Spanish). It is a social and economic territory comprised by 13 contiguous municipalities. We used two theoretical and methodological instruments to analyze impact simulations: 1) A Social Accounting Matrix (SAM) used for towns or territories, and 2) the Leontief type (1984) accounting multipliers associated and applied to the SAM.

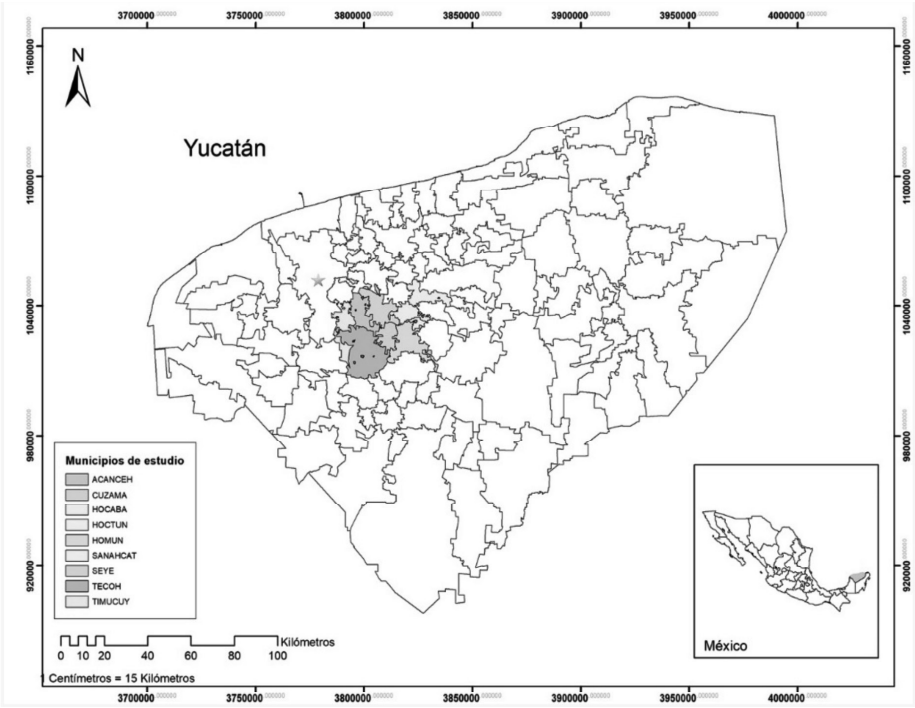
2. MATERIALS AND METHODS

2.1 STUDY AREA

The territory under study is "REGHAC", fragile and extremely vulnerable to contamination of its groundwater level, due to its geomorphopedological characteristics (karstic landscape, a large number of cenotes (open, semi-open, and cavern) and caves, Leptosols (LP) of different types –thin, shallow stony soils– (nudilitic, litic and rendzinas) some areas with slabs in the open or shallow

soils (5-10 cm); additionally 200 bird species –migratory and resident– have been identified, where cenotes are part of their habitat for food and shelter. Hence the importance of this territory due to the ecosystem services it provides (provision, cultural and regulation).

FIGURE 1: ANILLO DE LOS CENOTES (REGHAC).



Source: ArcGis, 2020.

REGHAC is a state level Natural Protected Area (NPA) since October 2013. It covers an area of 219,207 hectares, situated in a polygon of 13 municipalities: Seyé, Acanceh, Timucuy, Homún, Cuzamá, Tecoh, Tekit, Tahmek, Hoctún, Xocchel, Hocabá, Sanahcat and Huhí in the state of Yucatan. Due to its importance and location (in-land coastal plain), it belongs to what is in known as "the cenote route". Due to its ecological importance, it was designated in February 2009 a wetland site (Ramsar) registration 2,043.

One of REGHAC's objectives is to guarantee that the ecosystem services benefits derived from its territory –particularly hydrological ones– are distributed in an equitable manner with the inhabitants of these municipalities and thus improve their quality of life.

2.2 POPULATION AND SAMPLE

For our sample size we used a simple random method. We considered as a pre-selection criterion REGHAC rural localities with <2,500 inhabitants.

The values obtained to calculate the sample were the following:

$$n = \frac{NZ^2\,pq}{d^2(N-1) + Z^2\,pq}$$

TABLE 1.

Symbol	Value	Description
Z	1.96	Critical Z value was calculated from the normal curve tables. We considered a confidence level of 95%.
d	0.06	Absolute precision. Referred to the width of the desired confidence interval to determine the average value of the variable under study. For this study, 6%.
N	4,582	Sample size (occupied houses).
p	0.50	Approximate proportion in the referred population regarding the studied phenomenon. A 50% distribution was considered for this study.
q	0.50	Proportion of the referred population that does not present the phenomenon under study (1-p).

A minimum of 253 households was considered in the study. The N value derives from total households in localities with 100 to 2,500 inhabitants, in the municipalities of Acanceh, Cuzamá, Hocabá, Hoctún, Homún, Sanahcat, Seyé, Tecoh and Timucuy (see Figure 1); the total number of households is reported in the 2010 Population and Housing Census (INEGI, 2011).

In the calculation of the sample size the following municipalities of interest were considered, for the following reasons: 1) they are providers of environmental services; 2) are circumscribed to the polygon that delimits Anillo de los Cenotes subzone.

Localities were selected with the following criteria: 1) areas with >100 and <2,500 inhabitants and 2) a simple random sampling was applied for the other areas.

The number of households to be surveyed was determined based on the minimum sample size reference according to the number of households in the locality (see Table 2).

TABLE 2. LOCALITIES AND NUMBER OF RURAL HOUSEHOLDS INTERVIEWED.

n	Municipality	*n*	Village	Interviewed households
1	Acanceh	1	Canicab	25
		2	Petectunich	23
		3	Ticopó	17
		4	Tepich Carrillo	14
2	Cuzamá	5	Eknakán	20
3	Hocabá	6	Sahcabá	18
4	Hoctún	7	San José Oriente	21
5	Huhí	8	San Isidro Ochil	21
6	Sanahcat	9	Sanahcat	15
7	Seyé	10	Holactún	23
8	Tecoh	11	Itzincab	4
		12	Lepán	10
		13	Telchaquillo	26
		14	X-Kanchakan	4
9	Timucuy	15	Subincancab	20
Total				261

Source: Based on field work carried out by: GIPS BACAB, AC, 2019-2020.

3. THEORETICAL FRAMEWORK

3.1 SOCIAL ACCOUNTING MATRICES AND MULTIPLIER ANALYSIS APPLIED TO TOWNS

Taylor and Lybbert (2013) mention that Social Accounting Matrix (SAM's) applied to towns differ from Input Product Matrix (IPM's), and the information provided by the National Accounts System (NAS) in presenting detailed information regarding the different social groups. SAM's are also a flexible instrument and adapts well to the characteristics of our research, –particularly households– workforce and institutions. The accounts that structure SAM's applied to towns, comprise five large groups: 1) production activities, 2) production factors, 3) institutions, 4) capital, and 5) rest of the world (see Figure 2). According to Barceinas and Cervini (1993), SAM's are a wider IMP that includes not only the purchases and sales of inputs and products among sectors, but correspondingly the payments of activities to the productive factors.

Its scheme presents the economic activity circular flow: income redistribution factors and expenditure structure regarding institutions (businesses, households and government), including their external links. SAM's highlight an economy's flow of income and expenses.

FIGURE 2. SAM APPLIED TO TOWNS

Income	**Expenses**						
	1. Production activities	**2. Production factors**	**3. Institutions**		**4. Capital**	**5. Rest of the world**	**TOTAL**
			a. Households	**b. Government**			
1. Production activities	Community input-output matrix		Consume	Consume	Physical and human investment	Merchandise exports	Total Sales
2. Production factors	Added value of production						Added value of all factors of production
3. Institutions a Household		Payment to households for labor, capital and land services used in production	Transfers	Payments for labor services and transfers		Regional, national, and foreign remittances	Total remittances, total household income
b Government	Taxes		Direct taxes				Total government revenue
4. Capital **A Physical**			Saving	Saving			Total capital savings
5. Rest of the world a. Rest of the region b. Rest of the country c. Rest of the world	Imports		Purchases abroad				Imports from the rest of the world
TOTAL	Total payments	Total payments to capital and labor	Total expenses of the institutions		Total investment in capital	Exports	Totals Income / expenses

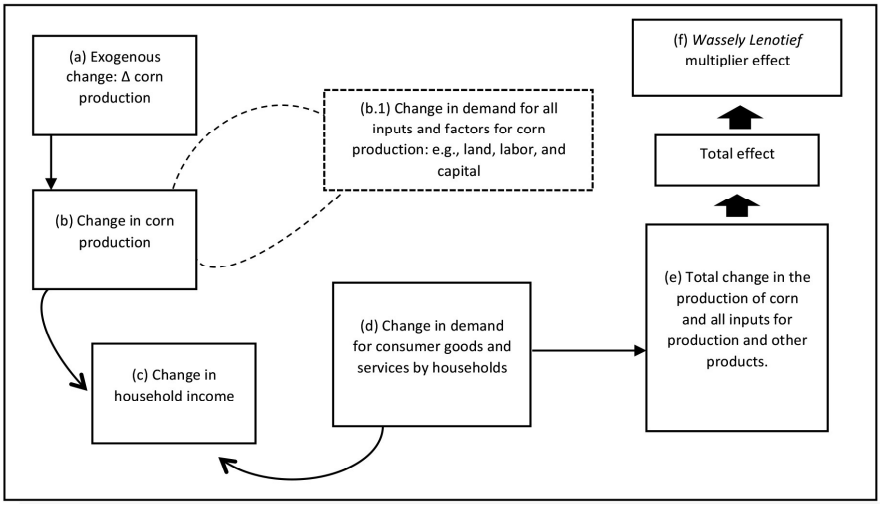
Source: Adapted from Becerril et. al. (1996).

Taylor and Adelman (1996) argue that the SAM's approach applied to communities or towns is ideal for the analysis of local economies, and captures its cultural and social diversity. SAM's offers a structure (analogous to a snapshot), particularly in reference to a specific year by representing the economic structure (technical production coefficients), the institutions that shape the community or territory, as well as the interactions of the local economy at a regional, national and international level.

Accounting multipliers analysis based on SAM's are more rigorous than IPM, mainly because the income and expenses distribution are considered endogenous, Barceinas and Cervini (1993), Becerril et al. (1996), Yúnez-Naude and Taylor (1999), Moniche, (2003), Barceinas, Crowe and Yúnez-Naude (1997) and, Taylor and Lybbert (2013) offer more details on this matter.

Figure 3 presents the direct and indirect impact caused by exogenous effects on the economy under study, considering Leontief (1984) multiplier effect.

FIGURE 3. LEONTIEF TYPE MULTIPLIER EFFECT FLOW DIAGRAM.



Source: Adapted from Taylor and Lybbert (2013).

The multisectoral simulation model (MSM) theoretical assumptions are: i) factor and products prices are fixed, ii) unemployment is present, iii) idle capacity of productive units, iv) constant returns to scale, v) linear and fixed-rate production function, and average and marginal propensities to consume are equal, and vi) demand drives the economy, emulating a Keynesian model. All income elasticities are unitary. For more specifics, one can see: Chiang (1999), Defourny and Thorbecke (1984), Barceinas and Cervini (1993), Huang (1970), Pyatt and Round (1979), Thorbecke and Jung (1996), Ten Raa (1995), Yúnez-Naude and Taylor (1995), Barceinas, Crowe and Yúnez-Naude (1997) and Leontief (1984).

The multisectoral design and analysis applied to SAM's was a Wassily Leontief type accounting multiplier (1984). The equation $\Delta X = MX + \Delta F = (IM)\ 1$ where ΔF represents the multiplier effect that is caused by an exogenous change and this in turn causes an increase in demand ΔX. In the figure the effect is triggered by an exogenous change in the increase in demand for corn production, in (a). This brings –under our theoretical assumptions– to a change in corn production (b). This change increases the demand for inputs and factors regarding the additional production of corn (captured in b.1). Due to the increase in corn production, involved households experience a direct increase in their income. Corn production helps them cover their self-consumption food needs, and the surplus they can sell (c). The household income increase shifts their demand for goods and services –there is an income outflow from the municipality due to the import of goods and services that are not produced in the territory– (d). This increase drives an overall change in corn production

and in purchase of input factors and other goods and services (e). This effect is known as the Leontief multiplier effect or (I-M)1 ΔF in mathematical notation.

3.2 MULTIPLYING SIMULATION MODELS (MSM)

Methodologically, and following Yúnez-Naude and Taylor (1999), the multiplier analysis applied to SAM's, evaluates the impact that exogenous changes –i.e. agricultural and environmental policy reforms– in our case a systematic analysis caused by the economic crisis –income loss– have on various components (activities, factors and institutions) within the communities of the REGHAC territory. The most important effects to analyze and quantify are those that occur in income and its distribution, investment and the institutions' expense structure.

Through a random method survey, we collected SAM's data regarding all income sources, within nine REGHAC municipalities, covering 15 rural localities (<2,500 inhabitants) and 261 households, from November 2019 to February 2020. A database was prepared using Microsoft Excel and Stata for the statistical and econometric analysis. We prepared the SAM's for REGHAC (according to the scheme in figure 2) and perform the estimates through GAMS the multipliers associated with the SAM's.

The information provided by SAM's helps evaluate the effects of changes in the elements that are exogenous at the national, regional, state or rural community economic model. These analyses are often known as Impact or Multiplier Analysis. To calculate multipliers, we use the inverse matrix of Leontief (1984) or inverse matrix of technical coefficients, one reason is the temporal stability of SAM's coefficients. The literature considers production, income and employment multipliers to estimate the effects of exogenous changes on (Yúnez-Naude and Taylor, 1999). Production, refers to the changes that will generate given the economy's changes in exogenous demand. Income, to the earnings received by households due to new productions, either locally or from exogenous effects. Employment, (in physical units) expected to be generated by new productions.

Numerous papers recommend emphasizing the analysis of production and income multipliers, due to the insufficiency of sectoral information regarding employment. However, in household models, small producers are affected by globalization, in particular by trade liberalization, through different direct and indirect means: i) markets local operation, and ii) relative sale prices and input's availability.

Small producers' characteristics influence their responses to the signals that the market or public policy provides them, some are: 1) Location, 2) Infra-structure, and 3) Availability of resources.

SAM's represent the monetary flow within the REGHAC territory, between activities and households, as well as the link amid the national and international economy. SAM's provide a photograph or snapshot of the local economy, and allows the analysis of external or exogenous impacts on household income and spending, production, inputs and commercial transactions, and understand how these impacts occur. The Leontief-type Multiplier analysis can provide indications about the direct and indirect impacts. However, this analysis has a restriction, since it does not take into account prices adjustment.

The first step to construct multipliers is SAM's account classification (which are n) into two groups:

i) Endogenous. For this study the production and households' factors, production activities and capital accounts.
ii) Exogenous. It contains the government and the rest of the world (region, country and the world).

FIGURE 4. SAM'S SCHEME BETWEEN ENDOGENOUS AND EXOGENOUS ACCOUNTS

	Endogenous accounts				
Income / Expenses	1. Factors	2. Institutions	3. Activities	4. Exogenous accounts	Total
1. Factors	0	0	T_{13}	X_1	Y_1
2. Institutions	T_{21}	T_{22}	0	X_2	Y_2
3. Activities	0	T_{32}	T_{33}	X_3	Y_3
4. Exogenous accounts	L_1	L_2	L_3	LX	Y_4
Total	Y_1	Y_2	Y_3	Y_4	

Source: Adapted and based on Figure 2.

Figure 4 presents the partition and transformation (matrixes) concerning three endogenous accounts. These matrices are:

T_{13} provides the added value produced by various activities regarding the received income by the production factors.

T_{33} gives us the required intermediate input (the input-output transaction matrix).

T_{21} is the map of household factorial income distribution (homes are characterized by their migratory activity).

T_{22} captures the income transfer with and between household groups.

T_{32} reflects household expenditure and consumption (including family consumption).

We group the accounts and normalize the SAM's, by dividing the amount in each cell by the total of its corresponding column. The resulting matrix contains the average spending propensities for all accounts, denoted by S.

Its elements are $S_{ij}\frac{m_{ij}}{\sum_i^n m_{ij}}$.

Where Sij and mij are the elements of matrix S and the SAM's, respectively. All exogenous to endogenous accounts payments are captured in a matrix X; which is constructed by eliminating from the SAM's the columns of the endogenous and the rows of the exogenous accounts. X is known as the exogenous injection matrix, whose dimension is: m x p. That is, m rows (endogenous accounts) and p columns (exogenous accounts). With the totals of the rows of X, we form vector x, of dimension m x 1: where: xj is the total per row of the j-th account of X matrix. By eliminating the rows and columns of the exogenous accounts in matrix S, we obtain the endogenous propensity matrix A, of dimension m x m.

Matrix A (comes from the following equation) is composed of submatrices Aij.

$$A = \begin{vmatrix} 0 & 0 & A_{13} \\ A_{21} & A_{22} & 0 \\ 0 & A_{32} & A_{33} \end{vmatrix}$$

The endogenous accounts of A form subgroups, in the intersection of the first rows and columns production factors accounts are located; at the second row and column intersection household or private institutions accounts are located; and the intersection of the third row and column, activities are located.

Thus the elements of the submatrix Aij, for all *i* other than *j*, represent the average spending propensities of the endogenous accounts of subgroup *i* with respect to those of subgroup *j*. Aii captures the average spending propensities of the endogenous accounts of the *i-th* subgroup with respect to itself. With M we designate the SAM's multipliers matrix, as well as the Leontief input-output multipliers, which is the result of the matrix operation: *M = (I-A)-1*, where: M is a square matrix, of dimension m x m, which contains the total effects of exogenous changes on endogenous accounts.

The product of the multiplier matrix times the vector of exogenous injections results in the y vector, which covers the total income of the endogenous accounts: y = Mx = (I-A)-1x

If there is a variation in the transfers from the exogenous to the endogenous accounts, matrix X is modified and consequently vector x is altered. This modifies the income of the endogenous accounts contained in y.

The total impact of an exogenous change in endogenous accounts is obtained by solving the operation: $ym = M\,xm$ where *ym* is the modified vector of total income from endogenous accounts, and *xm* is the modified vector of exogenous injections.

This operation not only captures the total effect on the production of an exogenous change, but also assesses its total impact on the income and expenditure structure of the institutions. SAM-based multiplier models have some implicit assumptions: agents take prices as given and all income elasticities are equal to one, the same is considered for input demands, including those of production factors.

This is a Keynesian type economic model, where the economy is driven by demand; thus, the supply of all goods is perfectly elastic. The latter could produce overestimations in the multiplier effects of the exogenous change simulations. The model is solved using The General Algebraic Modeling System (GAMS) and makes two income detriment simulations.

4. RESULTS

4.1. HOUSEHOLDS AND THEIR MEMBERS SOCIOECONOMIC STRUCTURE

Table 3 describes the sociodemographic profile of both men and women interviewed in the study area. In terms of age, it is an early adulthood and high labor productivity population, predominantly Spanish speaking even though Mayan is the language of the original REGHAC people.

Average formal education between female and male is statistically significant (t = 2.96). This is an unfortunate reality, where women achieve lower levels of formal education on average than men. Its causes involve multifactorial elements that are outside the scope of this study. The challenge is for the Federal and state governments, to reduce gender inequality and inequity, which represents an obstacle for the economic and sustainable development that is desired in the territory.

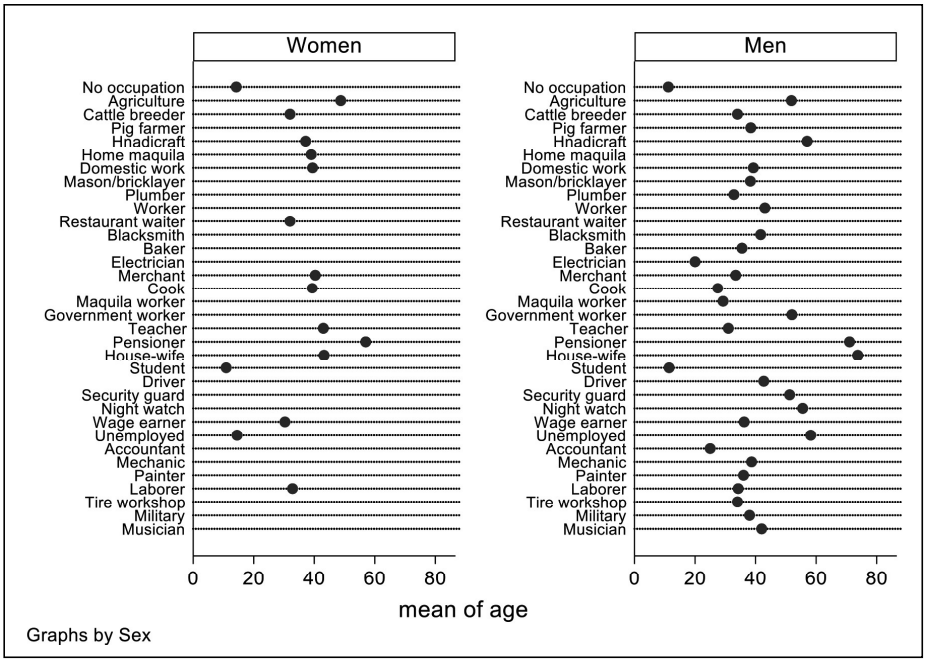
TABLE 3. HOUSEHOLD MEMBERS' SOCIODEMOGRAPHIC DATA.

Variable (t Test)	Female (541)	Male (540)	|t|
Age	33.17	32.30	0.68
Education (in years)	6.36	7.08	2.96*
Speaks Spanish (1 = Yes)	0.90	0.90	0.30
Speaks Maya (1 = Yes)	0.62	0.62	0.16
Speaks English (1 = Yes)	0.000	0.003	1.41

n=1,081; *p<0.05

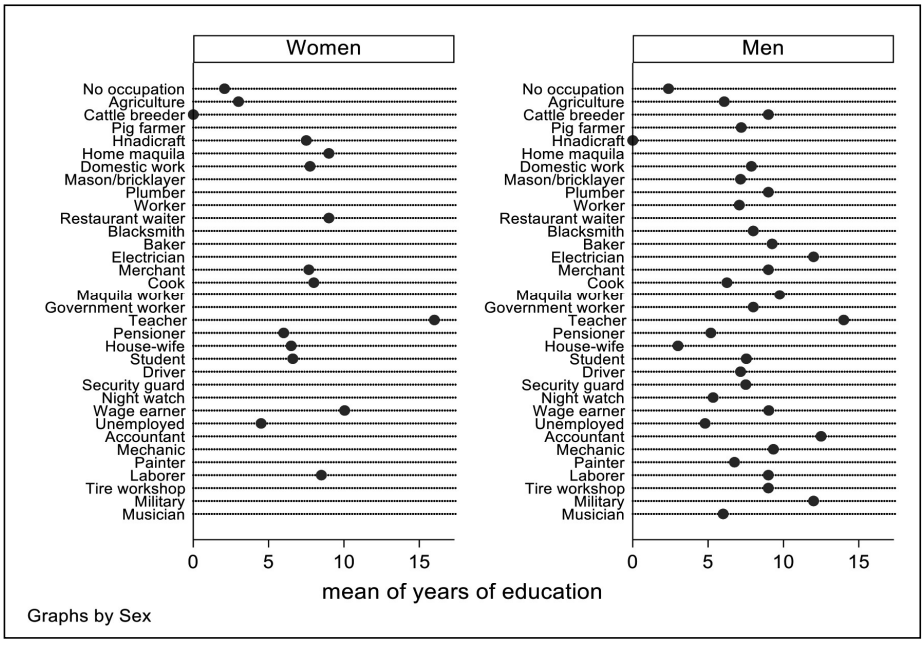
Work occupation of REDHAC inhabitants is important for our analysis; Figure 5 reveals and illustrates the evidence between the average age in completed years and the economic activity reported by people we interviewed. The data describes the average women and men´s age and their main occupation. Agricultural activity is carried out by both men and women with an average age of 50 years. For selected skills (main occupation) for women such as domestic maquila (home assembly), is carried out by women with an average age of 40 years. Men reported as their main occupation being: driver, plumber, electrician, night watchman, security guard, mechanic, painter, with an average age of 40 years. A relevant datum is that polyculture agricultural activity is in the hands of men –mainly- adults–, over 50 years of age.

FIGURE 5. WORK OCCUPATION BY AGE AND GENDER



Source: Elaborated with data from the income survey – in full, 2020.

FIGURE 6. MAIN OCCUPATION BY AVERAGE YEARS OF EDUCATION AND GENDER



Source: With data from the income survey – in full, 2020.

Women or Men	
1	No occupation
2	Agriculture
3	Cattle breeder
4	Pig farmer
5	Handicraft
6	Home maquila
7	Domestic work
8	Mason/bricklayer
9	Plumber
10	
11	Worker
12	Restaurant waiter
13	Blacksmith
14	Baker
15	Electrician
16	Merchant
17	Cook
18	Maquila worker
19	Government worker
20	Teacher
21	Pensioner
22	House-wife
23	Student
24	Driver
25	Security guard
26	Night watch
27	Wage earner
28	Unemployed
29	Accountant
30	Mechanic
31	House painter
32	Laborer
33	Tire workshop
34	Military
35	Musician
Average years of education	

Figure 6 helps to understand Yucatan's rural areas. Inhabitants employed in the primary sector (agriculture and livestock), apart from being adults, are those with the lowest formal education. In table 3 we reported the statistically significant difference. Even though the women and men in this territory with a profession and a steady income are the least vulnerable: teachers, accountants, military personnel, among others; the women and men without the first years of schooling completed make up the population with informal trades and without any social security contract.

On the other hand, Table 4 summarizes households' socioeconomic characteristics in relation to their activity type of activity: primary (68.2%), secondary (19.2%) and tertiary (12.6%) sector. The data highlights that households with the highest annual average income carry out secondary and tertiary activities, where only a minor percentage of households in extreme poverty are located in the service sector.

TABLE 4. HOUSEHOLD SOCIOECONOMIC CHARACTERISTICS (TYPE OF ACTIVITY), 2020.

Household description	Household activity		
	Primary (12.64%)	Secondary (19.16%)	Tertiary (68.20%)
Head of household is male (%)	96.96	100.00	72.24
Average age of head of household	52.15	45.82	49.64
Average education of head of household (years)	6.18	6.72	6.95
Family size	4.12	4.58	4.06
Average annual income ($ MXN)	66,320.36	90,726.72	89,636.46
Size of land (Ha)	0.25	0.36	0.07
Number of Public Policy Programs	2.15	1.14	1.26
Annual average firewood consumption ($ MXN)	4,193.30	3,349.90	3,200.40
Do they own a plot of land (solar) (%)	96.96	76.00	88.76
Average crops in plot of land (solar)	2.96	2.94	3.01
Average animals in plot of land (solar)	4.66	6.44	3.78
Extreme poverty households (%)	45.45	44.00	26.96

Source: Interviews from 261 households interviewed, 2020.

Table 4 provides a photograph of REGHAC's situation prior to the pandemic, and figures 2 and 3 are corroborated. We highlight the number of public policy programs according to household type. Particularly extreme poverty households that are in a vulnerable situation, 45% of these are in the primary sector (agriculture), compared to households in the tertiary sector –services–, with an incidence of only 26.96%.

4.2 MULTISECTORAL ANALYSIS RESULTS

COVID-19 has had impacts on a global, national and local scale causing an economic activity slowdown, with countless repercussions to our health, social and economic systems. The Economic Impact Survey due to COVID-19 of the National Institute of Statistics, Geography and Informatics (INEGI, in Spanish), in its June 2020 publication estimates that just over half (59.6%) of businesses in Mexico implemented as preventive measures temporary closures. Regarding the economic importance, 41.4% of companies considered as essential undertook temporary closings for 21 days or more, while non-essential ones represented 50.5%. Furthermore 93.2% of businesses registered at least one form of affectation due to COVID-19. The greatest was income decrease, with 91.3 percent, followed by a reduced demand that at the national level was reported by 72.6% of surveyed companies (INEGI, 2020).

INEGI's (June 2020) COVID-19 telephone survey regarding the labor market, estimates that 32.9 million employed people (23.5% worked from home), 30.3% did not work standard hours, 46.1% decreased their income and 21.8% were temporarily absent from their work but sustained a labor relationship. The report indicates that in 30.4% of households some member lost their job due to the pandemic and in 65.1% their income decreased during the contingency. 37.4% of the homes with an income decrease, their members had to sell some goods, borrow money or resort to their savings.

These numbers provide insight to calculate through REGHAC-SAM's, the impact that the rural households' income decrease would have. SAM's 2020 reports the income obtained in 2019 in current pesos, the hypothetical simulation analysis would be an income loss of three, five or 12 months.

TABLE 5. RECHAG´S ECONOMY STRUCTURE
(THOUSANDS OF CURRENT PESOS) IN 2019

Territory's aggregate economy	Current pesos 2019
GDP	$471,813.4
Aggregate offer	$606,931.6
Import Activities	$128,684.2
Export Activities	$3,966.5
Migrant remittances	$349,408.4
Household imports	$220,245.4
Subsidies	$29,285.2

Source: Social Accounting Matrix REGHAC, 2020.

To interpret the relative changes Table 5 reports REGHAC's economy aggregates. A $471 million pesos GDP in 2019. The service sector provides an income of $349 million pesos that comes, according to face-to-face interviews in Merida (the state capital) and the Riviera Maya, via trades, such as: domestic workers, bricklayers, painters, mechanics, electricians, dishwashers, cooks, drivers, etc. With this income, REGHAC's households buy goods and services, mostly imported (they are produced and offered outside the territory) –in the best of cases– and from other parts of the world.

The $349.4 million pesos per year, relate to a $72,793.36 annual income distribution per household ($6,066.11 household monthly income), to a monthly per-capital income average of $1,378.66. The model simulates an income loss of $145.6 million pesos, that is, 41.6% of the livelihood of households in 2020 that are employed in trades and that due to the COVID-19 lockdown lost their source of income. The model does not consider, in the loss, households that kept their income while working at home: teachers, professionals employed in certain companies in the area, and other jobs in the economy formal sector, which unfortunately were the fewest.

The analysis simulates an income decrease by household members working in the informal service sector in Merida, capital city, (ceteris paribus all other sectors). The model's objective variable is to maximize the Gross Domestic Product (GDP).

TABLE 6. REGHAC'S LEONTIEF MULTIPLIER EFFECTS, 2020

Anillo de los Cenotes 2020 (15 municipalities)			*Leontief* multiplier effects	
			Five month income loss due to lockdown	Three month income loss due to lockdown
Activities	Cornfield (Milpa)	1	-33.80	-20.28
	Family garden (Solar)	2	-34.30	-20.58
	Apiculture	3	-10.70	-6.42
	Natural resources	4	-37.94	-22.76
	Handicrafts	5	-20.96	-12.57
	Commerce	6	-37.96	-22.78
	Services	7	-40.86	-24.52
Factors	Waged employee	8	-40.84	-24.50
	Family work	9	-38.64	-23.18
	Land	10	-33.80	-20.18
	Capital	11	-39.51	-23.70
Institutions	Primary activity household	12	-37.22	-22.33
	Secondary activity household	13	-38.19	-22.91
	Tertiary activity household	14	-38.03	-22.82
	Government	15	-11.45	-6.87
	JAPAY[2]	16	-38.13	-22.88
Capital	Financial	17	-38.01	-22.80
	Human	18	-38.01	-22.81
Exterior	Region	19	-38.01	-22.81
	Mexico	20	31.02	-18.61
Total		21		
Gross Domestic Product			-40.31	-24.19

Source: Multisectoral analysis results reported by GAMS.[2]

2 Japay is the satte Office of Water.

The hypothetical scenario results, three and five months' income loss –conservative objective and credible to local conditions– show a resounding GDP drop. The model suggests a 23% to 38% detriment in both scenarios regarding household income drop, which corresponds to the income received by REGHAC inhabitants. The majority of the population reported being employed in the service sector with informal jobs. This affects the total of activities within the area under study: cornfield agriculture, cultivation activities (backyard of homes), beekeeping, use of natural resources, handicrafts and local commercial activity. To this we must be add the damage caused by tropical storm Cristobal (end of May beginning of June 2020, which is beyond the scope of our analysis).

5. CONCLUSIONS AND RECOMMENDATIONS

The analysis fulfills its general objective by quantifying the direct and indirect effects of the total and partial closure of key sectors of the economy in Yucatan during the "Jornada de Sana Distancia" and the "New Normal" regarding the weekly epidemiological traffic light and undertaking a simulation analysis of the three and five months' closure of activities and income reduction implications to rural households.

The analysis also responds to the question posed about the social and economic implication of the closure of economic activities considered –erroneously– as non-essential, but support thousands of families in Yucatan. This reliable sample provides robust and systematic information, with a high level of reliability and a low margin of error on the direct and indirect impacts on the detriment of REGHAC household income in rural areas. Knowing that the theoretical approach of Leontief's (1984) multiplier effect, regarding the income decrease of households with a pendular migration (every day) to Merida (state capital), indirectly affects the goods and services that these households demand in their localities of origin. The result is a sharp drop in the local and regional economy. The results demonstrate that keeping the population alive under lockdown and social distancing has been highly costly. Household income fall has led to the closure of other activities, multiplier effect, considering the circular flow of income and expenses in this theoretical approach.

The analysis supports the hypothesis of the draconian measure of a total closure of the economy, surpassing an income loss above 30%, an expensive and ineffective measure. According to Bloombergs' analysis, Mexico is classified as the worst country to live in the era of COVID-19 (53rd place out of 53 countries, www.bloomberg.com/graphics/covid-resilience-ranking). The

measures to manage the pandemic by the Federal Government have been costly in terms of family income detriment and not very effective.

To recover and expand the economy in Yucatan, it is prudent to follow orderly, energetic and expeditious policies, without restrictions. Governments should consider the experience of the school of economic thought, particularly the Keynesian school, which succeeded in lifting economies out of the 1929 Great Depression, the real estate crisis of 2008, and the multiplier effects on the circular flow of income and expenditure of institutions. One must consider the economy's activities with greater multiplicative effects. Currently, many governments are providing fiscal stimuli in the order of 10% of GDP or higher. In addition, it is imminent that small business will have to reconvert in the way they offer goods and services, and adopt new customer service sanitary standards Digital platforms and home delivery are opportunity areas. Society must be attentive of buying what is well "Made in Yucatan", and buying products that come from Yucatan´s rural areas. We should remember that a peso spent on a product of Yucatan is income to local households –in terms of the Leontief multiplier effect–, with direct and indirect effects due to the economy's linkages. Derived from the Leontief multisectoral analysis and with a Keynesian theoretical assumption, we suggest the following actions to prompt the region's economic recovery:

- Reduce gender inequality and incorporate an inclusive model for indigenous communities, as an empowerment precursor and grassroots' development, to foster fair local employment.
- Promote on a global and local scale the benefits of Mayan apiculture, its nutritional values, ecosystem benefits and low environmental impact.
- Promote local gastronomy (gourmet type value) and present local crops that come from polycultures [such as cornfield (milpa) and Mayan family garden (solar)], and the Mayan people's culture and values regarding their identity, thought and philosophy.
- Promote alternative tourism, –not massive or resort style–, but one that provides the experience of exploring and venturing into the pre-Hispanic Mayan Cenotes, based on guides and interpretations in the hands of the Mayan people and culture.
- Promote fair market. From the producer to the chef or final consumer.
- Promote and extension of the use, handling, application and final disposal of agrochemical containers and packaging.

- Promote and participate in native seeds markets and fairs (heirloom) for corn, squash, *espelon* (Mayan bean), beans, *ibes* (white bean), to mention a few that are used in the milpa's polyculture, as well as in the solar.
- Promote knowledge and knowledge exchange in a ludic and multicultural manner.
- Promote and disseminate local agrobiodiversity. The nutritional properties of each crop.
- Promote gastronomic circuits with local crops, showing and underscoring the attributes of local agrobiodiversity. With direct benefits to REGHAC's rural inhabitants.
- Promote green economy and circular economy actions.
- Have higher education institutions and research centers be involved –with a multicultural approach– in REGHAC with extension projects, knowledge exchange.
- Promote youth entrepreneurship actions that solve local, grassroots problems and concerns in REGHAC's territory.
- As an urgent issue, innovate and make a change in sewage and waste water disposal of homes, public and private institutions and livestock activities.

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